Two short accounts of the eruption have been published in Icelandic, the one by Prof. Hallgrimson, the other by Herr Nielsens. These have been translated for me by Herr Matthias Jockumsson, of Reykjavik, to whom I beg to express my acknowledgments. According to Hallgrimson there are fourteen small craters situated in a line passing from west-south-west to east-north-east, which line, if prolonged, would pass through the centre of the craters on the summit of Hekla. The distance between the extreme craters of February 27 is about 6,000 feet. The lava flowed more than a mile to the south of the largest of the new craters, but the main stream flowed to the north and north-east, and nearly reached the Mountain Valaknúkr.

Nielsens approached the scene of the eruption, a month after its commencement, from the north-west, and passing between Valafell and Valaknukr, he went due south to Krakatinkr, along the eastern edge of the new lava. From the summit of Krakatinkr he looked down into the principal crater, and saw that it opened towards the east, and that its sides were almost perpendicular. The lava within it was seen to be agitated by a wavy motion like the billows of the sea, and a stream of glowing lava was moving towards the south. A good deal of vapour was apparent, and loud noises, as of the roaring of the sea. The valley is most steep, in a line which passes north-west and south-east from Raudfossafyall; here, consequently, was the greatest depth of lava. The stream varies from 10 to 100 feet in thickness, and in some places it has burrowed beneath the snow and ice. The lava is almost black in colour, and closely resembles the old Hekla lavas in texture; as it cooled it split up with great noise and commotion.

Nielsens again visited the neighbourhood of the new crater on June 9. The lava had not increased in quantity since the beginning of April, but columns of vapour still arose from it, and small quantities of ashes and of pumice had fallen during April and May. He crossed the warm lava and managed to ascend the largest crater, which was found to be 90 feet in depth and about 100 feet in circumference.

Two days after our visit to the scene of the eruption of February 27 we ascended Mount Hekla from the south-west. The general details of the ascent I now copy from my journal, hoping at some future time to produce them in a less desultory form, and to give an account of the analysis of some of the lavas of Hekla.

We left Galtalœkr Farm at 9.40 A.M., taking with us G. Zöega, a guide from Reykjavik, together with the occupant of the Nœfholt Farm, on the flanks of Hekla. (Route *b b* on the map). Having crossed the Vestri-Rángá, we proceeded nearly due south, passed the Nœfholt Farm, near which we came upon the lava of 1845; and then passed over some very rough lava-strewn ground covered with volcanic ash, which concealed holes into which the ponies sometimes stumbled and fell. The lava of 1845 is covered with the same moss which we noticed on the old lava near the crater of 1878, which causes it to look much older. When the ascent became greater, we left the ponies. Distance to foot of steep incline about seven miles from Galtalœkr. Followed the southern boundary of the lava-field of 1845, until we reached a steep incline which we ascended. Crossed a small portion of the old lava field, then a tract covered with volcanic ashes, and finally found ourselves at the bottom of a steep slope covered with snow, beneath which water was heard rushing downwards. The ascent of this slope without alpenstocks was not easy. Several other snow slopes were crossed, and we then found ourselves near the crater of 1845—the most westerly of the four craters on the summit of Hekla. Above this we saw a crater with a red smoking mound within it; then in succession the third and fourth craters, and beyond the most easterly crater a nearly level snow-covered waste full of lava blocks. From the most easterly extremity of this, which was reached at 2.30 P.M., we looked down upon the principal crater of 1878. The summit of Hekla is covered with much ash, sand, and red pumice, together with lavas of every degree of compactness, from the most vesicular up to obsidian. The descent over the snow-slopes was troublesome, on account of their steepness and the slipperiness of the snow, but we regained the spot at which we had left the ponies at 5 P.M.

Hekla was ascended for the first time in the year 1770. The difficulties of the ascent have been much exaggerated subsequently. Many travellers have made no attempt to scale the mountain. Even the "American in Iceland," who was in the neighbourhood of Hekla only three years ago, asserts that "the obstacles, real and imaginary, stated to be in the way, such as tortuous and difficult paths, swollen rivers, depth of snow, treacherous bogs, and the evident indisposition of the guides, perhaps from superstitious fears, to make the attempt, compelled us to turn our backs upon this snowy monarch of Iceland." Other writers speak of the "fearful precipices" and of places where "a slip would be to roll to destruction."

The fact is, it is quite an easy mountain to climb, in witness whereof I may mention the very abnormal conditions under which I ascended it. The day preceding our ascent had been extremely wet, and there was at least a possibility of a downpour on the day itself; moreover, there were streams to ford, and I had consequently put on waterproof wading stockings, and the usual accompaniment of thick iron-clad wading clogs, which, although the most cumbrous things in the world to walk in, are well suited for riding in the humid climate of Iceland. If the steepness and length of the ascent had required it, of course I should have left these encumbrances with the ponies, but it was quite unnecessary, and I accomplished the ascent without difficulty in this unwieldy equipment. Surely a mountain of this height was never before ascended in clogs and waders, and the fact of its being possible to do so without inconvenience, is a sufficient answer to those who would make the ascent of Hekla a dangerous and difficult feat.

G. F. RODWELL

NOTES

THE moderation in tone of Viscount Cardwell's short address at the opening of Owens College, makes his estimate of the position of that institution all the more worthy of acceptance. He is inclined to regard it as the most singular acquisition to the academical strength of the county since the middle ages; and we venture to think that one chief reason why it occupies so distinguished a position is the completeness, the all-roundness of the education which it furnishes. There, science and letters are on an equal footing, and it will only be when this is the case in all our educational institutions that the educational apparatus of the country will be thoroughly efficient. The fact that Owens College now administers funds exceeding 400,000*l*., all obtained from private sources, is one proof that it fills a great want. We have on previous occasions spoken of its claims to be erected into a university. The tone of Lord Carnarvon's address at Saltaire, was in effect similar to that of Lord Cardwell; education is incomplete unless all our faculties have equally fair play.

ACCORDING to the Naples correspondent of the *Times*, Prof. Palmieri does not think there is any likelihood of a violent eruption of Vesuvius. The mountain has been in an eruptive state for two years; the cup is full, and must run over, but will probably do so quietly. The state of Vesuvius gives some interest to the project of the construction of a railway intended to conduct travellers from Naples to the margin of the crater. The scheme, proposed by a Neapolitan banker, has just been adopted.

According to the *Italie*, the waggons will be dragged by a rope. The length of the way will be only 840 metres, and the altitude reached 490 metres above the level of the sea. Each waggon will have only four seats, and four waggons, carrying sixteen passengers, will go up at the same time that four others loaded with sixteen persons will come down. Each waggon will be supplied with a patent brake for stopping instantly if the rope breaks.

THE death is announced, at Milan, of Signor Giulio Curioni, a distinguished chemist, metallurgist, and geologist, in his 82nd year.

MR. EDISON, the *Polytechnic Review* states, has made some experiments with a view to accomplishing the reading of the phonograph record by sight; but although a fundamental form exists for each articulated sound, he finds it very difficult to free the record from what might be called accidental influences; for so sensitive are these markings that the same sound uttered by different persons, or the manner in which it is spoken, the distance of the mouth from the instrument, the force with which it is spoken, or the speed with which the barrel is rotated, gives a different form of indentation. Vowel sounds appear to be but little affected by these variations as compared with consonants.

ABOUT 14,000 telephones, we learn from the *Polytechnic Review*, had been introduced into the United States up to the close of the year 1877, and the manufacturers are receiving orders at the rate of about a thousand a month.

WE learn from the Report of the British Association Committee on Erratic Blocks, presented by Rev. H. W. Crosskey, that the Committee were supplied with notes on boulders near Kendal by Mr. J. R. Dakyng. The most remarkable are those of the granite of Wastdale Crag, near Shap Wells, the distribution of which seems to show that they must have travelled over the high ground south of the granitic area, and not have followed the course of the present drainage. The general due south course of the boulders is shown by their distribution south of Kendal. They have been traced as far south as Milnthrops and occupy a narrow band of country whose long axis point, directly to the granite of Shap Fells. The most westerly are some near Hincaster, and a line drawn from the most westerly outcrop of granite on Shap Fells to these boulders bears south by west. The most easterly in this neighbourhood is in a field near Windy Hill, about two miles south-east of Kendal railway station, but one has been found high up on the side of Grayrigg Fell. Boulders of the dark compact altered rock that surrounds the granitic area are generally found along with the granite boulders. When the localities where granite boulders occur are marked on a map, the steady lineal north and south direction of their course is very striking. Boulders of the ordinary volcanic rocks of the Lake Mountains indicate other directions for the ice-flows. One of these may be seen two and a half miles out of Kendal, and east of the line of granite boulders. As the granitic area of Shap Fells is at the extreme east end of the volcanic rocks, this boulder must have crossed the line of flow along which the granite boulders travelled. Some new facts were reported by Mr. MacIntosh relative to the derivation of boulders already recorded, the existence of several large boulders previously unnoted, and by the extent to which Ireland has sent erratics into England. The report further contained descriptions of the position and character of many large boulders and groups of boulders in Leicestershire and Staffordshire.

IT is announced that a second session of the International Congress of Ethnographical Science which met under the patronage of the French government in July last at the Palace of the Trocadéro, will be held on October 10 next at the Palace of the Tuileries. This session is to be held in order that those who were unable to attend in Paris in July last may now have an opportunity of being present at the congress. In the course of a few days a programme will be published of the questions to which special attention is to be called. The committee of the Ethnographical Society of Paris which is organising the congress are especially desirous that England should be well represented on the occasion.

IN a recent issue of the *Indian Tea Gazette* we find some interesting notes of an attempted journey towards China, overland from Assam, extracted from the journal of Mr. C. H. Lepper, who, attracted to the subject, no doubt, by his previous residence in China and Japan, has always kept in view, since his arrival in Assam, the idea of taking advantage of the magnificent Brahmapootra as a road to within about 200 miles of the frontier of the province of Yünnan. His residence being only sixteen miles from Suddya, the furthest outpost on the north-east of India, he has had constant opportunities of making inquiries from the intervening peoples in regard to the distance, state of the tribes, &c., between our frontier and China. These proved so satisfactory in their results that early in 1876 he was induced to make an attempt to advance as far as possible in the direction of China with the object of obtaining more precise and practical information. Before the party left Suddya, the *mehla* or fair for the hill tribes had just been held, at which Chow Mang Ti, a chief of the Kamptis, acts as interpreter for that tribe and the Singfoos, who assemble there in considerable numbers. His brother, Chow Kun, accompanied Mr. Lepper as head of the Kampti guides, and in the course of conversation Chow Mang Ti stated that there would be no difficulty in getting through the intervening country to the Chinese border. Passing up the Brahmapootra, the party entered the Tenga Pani River through the Noa Dehing. They found the first three or four miles had a sandy bottom, with great quantities of the silkworm-feeding *Soom* tree on the banks, on which the forest soon became dense and the scenery beautiful. Near the first rapid is a pretty islet, named Shikar Mazeli, which, when seen from a point a little further up the stream, Mr. Lepper describes as "perfectly enchanting." After passing the village of Juna or Chuna, Mr. Lepper says "we soon came to a bend, having a very high forest facing us on a hill, containing banyan, valuable saul trees in great quantities, also uriam and soom trees; we noticed, too, the Bazal bamboo appeared again, bamboos up to within a short distance of this hill not having been seen on the river. The 'surat,' a horrid leaf, which, if touched, causes intense pain for days, is prevalent, also a kind of wild chestnut. Plantains, *toku pat*, *tora pat*, tree ferns, orchids, and other parasites, all help together with graceful patches of cane to make the picture perfect." Owing to numerous rapids progress was slow, and it was late on the fourth day when the party reached Shangkam, where they were kindly received by the Kamptis. After they had waited some time, Chow Mang Ti arrived from Suddya, and to their great disappointment assured them that it would be useless to attempt to proceed towards China at that time of the year, as the rainy season had set in. He, however, gave some information on points connected with the route to China. "It takes eight days," he said, "to reach Hobong, between which place and this you could get no supplies, and it would take you about sixteen days to get there. Hobong is a large town. Then it takes us eight days more to reach the Irrawaddy River, and would take you at least sixteen or eighteen days. It is between Hobong and the Irrawaddy that the ascent I told you of has to be made. A little past Hobong are the two hills of almost pure silver; . . . there is a great quantity of gold there too, which gives that little colony of ours the name of Kamp Thi, meaning gold country, by which name you call all of us, who are really Shans from Shan, a country lying nearer China, having a strip of Singfoo country lying between us and our colony of Kamp Thi. The Singfoos, again, lie between our Shan country and China. This Hobong route is better than the Hukong route, which leads to Burmah, as the Noa Dehing is not navigable now." As it was impossible to prosecute his projected journey without Chow Mang Ti's assistance, Mr. Lepper deemed it prudent to acknowledge the weight of the arguments which he advanced against making the attempt at that season, the more so as he was aware that the Government of India objected to Europeans crossing into the territories of the hill-tribes, and he had only obtained permission to cross the "inner line" on the ground that he desired to visit the Brahma Khund or Sacred Pool of Brahma. He accordingly descended the Tenga Pani River, and then proceeding up the Brahmapootra, visited the Sacred Pool, a spot which few living Europeans have ever reached.

From time to time we have given various examples of the progressive tendencies of the Japanese in many directions, and we are glad to be able to supplement them with the information that they are turning their attention to the dredging of their harbours. We learn from a Japanese contemporary that the ports of Niigata, Ishinomaki, and others are to be dredged and improved in such a way as to be most convenient for shipping. The Bay of Hachiro, in the province of Ugo, is to be dredged, at the estimated cost of a million *yen*. Mr. John Perry, engineer in the employ of the Public Works Department, and a number of students of the Survey Department were sent there in April in order to survey the bay, and their inspection will probably be completed in October. This work is the more important as there is no safe shelter for vessels in stormy weather between Hakodate and Tsuruga.

Mr. Edward Stanford has the following books and maps preparing for publication:—A fifth edition, greatly enlarged, of "The Physical Geology and Geography of Great Britain," by Alexander C. Ramsay, LL.D., F.R.S., Director-General of the Geological Surveys of the United Kingdom, with Geological Map printed in Colours, and numerous Illustrations; "Notes of a Tour in America from August 7 to November 17, 1877," by H. Hussey Vivian, M.P., F.G.S., with Map; "The Fairyland of Science: Chapters for Children," by Arabella B. Buckley, Illustrated; "Karamania; or, Life in Asiatic Turkey: a Journal of Travel in Cilicia (Pedias and Trachæa), Isauria, and Parts of Lycaonia and Cappadocia," by the Rev. E. J. Davis, M.A., English Episcopal Chaplain, Alexandria, Illustrated; "Manual of Physical, Historical, and Political Geography for Schools," by Keith Johnston, F.R.G.S., with numerous Maps and Illustrations; "Stanford's Compendium of Geography and Travel—Europe," Edited and Extended by Prof. A. Ramsay, F.R.S.; "Australasia," Edited and Extended by A. R. Wallace, F.R.G.S.; also in preparation, uniform with the last, "Asia," Edited and Extended by Col. Henry Yule, C.B., F.R.G.S., "North America," Edited and Extended by Prof. F. V. Hayden, of the United States Geological Survey; "Elementary Physics for Middle-Class Schools, with Experiments and Illustrations, to which are added Examination Questions on each Section," by John A. Bower, Science Master, Middle Class School, Cowper Street, London. Among Maps Mr. Stanford will publish an "Orographical Map of Asia," for Use in Schools and Colleges," Edited by Prof. Alexander C. Ramsay, F.R.S.; "Library Map of Japan," Compiled by E. Knipping; size, 4 feet 6 inches by 5 feet 6 inches; scale 17 miles to an inch; this is an entirely new and original map, compiled from the various large divisional Maps prepared by the Japanese, and corrected and extended from journeys made for the purpose by the author; Supplementary maps show the railways, chief roads, telegraphs, and lighthouses, and the new administrative divisions introduced in 1876; "Library Map of Africa," new edition, with the Results of all Recent Explorations carefully laid down; "School Map of Africa;" new edition; size, 50 inches by 58; scale 118 miles to an inch; "Library Map of South America;" new edition; "Library Map of Australia," in nine sheets; constructed from the most recent Official Documents furnished by the Surveyors-General, showing the Details of Recent Explorations, and including a supplementary Map of Tasmania; on the same scale; "General Map of Australia," with all the recent explorations, the roads, railways; and a "School Map of New Zealand."

Messrs. E. and F. N. Spon will publish during the forthcoming season:—"The Chemist's Pocket-Book," by Thos. Bayley; "The Power and Speed of Steam Vessels Calculated by Rules adapted for Vessels of all Types," by W. Bury, Mem. Inst. M.E.; "A Treatise on Bridge and Roof Construction," by Karl von Ritter, translated from the German by Lieut. Sankey, R.E.; "Applied Mechanics," by Prof. Calcott Reilly, M. Inst. C.E.; "Graphic Arithmetic," by G. S. Clarke, Instructor in Geometrical Drawing, Royal Indian Engineering College, Cooper's Hill; and a "Supplement to Spon's Dictionary of Engineering." M. Ch. du Moncel has published in the "Bibliothèque des Merveilles" a volume on "The Telephone, Microphone, and Phonograph," in which he describes in a popular form all the discoveries which for the last two years have astonished the world.

Messrs. Williams and Norgate have sent us "Karl Ernst von Baer; eine biographische Skizze," by Dr. Ludwig Stieda, and "Karl Freidrich Gauss, Zwölf Kapitel aus seinem Leben," by Ludwig Hänselmann. Messrs. Longmans and Co. have published a fourth edition of Prof. Fleeming Jenkin's text-book on "Electricity and Magnetism.'

From America we have received the "Bibliography of North American Palæontology," by Dr. White and Prof. Alleyne Nicholson (Washington Government Printing Office), and "Annals of the Astronomical Observatory of Harvard College," vol. iv. part 2 (Cambridge, U.S.: Wilson and Son). From Australia we have Decade 5 of the "Prodromus of the Palæontology of Victoria," by Mr. F. McCoy, of the Victoria Geological Survey; "Meteorological Observations made at Adelaide Observatory during 1878," by Mr. Charles Todd; "Mineral Statistics of Victoria for 1877," and "Report of the Mining Surveyors for Victoria for Quarter ended March 31, 1878."

The Chilian government has now established a meteorological service in all the ports that are connected by telegraph, and the daily observations are published in the government gazette at Santiago.

An earthquake was felt at Pic-du-Midi Observatory on Wednesday, September 25, at 8h. 53m. in the morning. The snow was falling heavily. Heavy falls of snow have also been recorded in the Oberland, and communications with St. Gothard have been interrupted. Shortly after midnight on Friday the shock of an earthquake was felt at Osterath, in Germany.

From the 16th to the 18th of August the city of Cartago in Costa Rica, in Central America, was visited by five distinct shocks of earthquake. No particular damage was caused. What is to be noticed is the meteorological result: that the weather was changed, being attended by heavy showers that flooded the rivers. In all earthquake countries it is believed the weather is affected by such phenomena, and it is desirable that observations should be recorded, showing the influence of earthquakes on weather. It has been alleged that the Comrie earthquakes in Perthshire came on after rains and floods of the river.

PROF. KARL ARENDTS, of Munich, has been nominated corresponding member of the Lisbon Geographical Society, in acknowledgment of his merits in geography. Prof. Arendts is the editor of a new geographical serial, entitled "Deutsche Rundschau für Geographie und Statistik," published in monthly parts by Hartleben, of Vienna.

"VIH CHE SIN LOO" (magazine for the propagation of knowledge) is the title of a new monthly publication in the Chinese language, edited by Dr. Edkins, of Pekin.

SECCHI'S "Meteorologica Romana" has just been published by the Italian government. The last revision of proofs was made by Secchi's friend, Sig. Ferrari, death having prevented the great astronomer himself from finishing this last part of his work on the meteorology and climatology of the Eternal City.

THE twenty-third meeting of German and Austrian apiculturists took place at Greifswald on September 11-13, and was attended by over 700 persons.

THE International Agreement regarding the steps to be taken for protecting the wine-growing districts against phylloxera, was signed at Berne on September 17.

RECENT borings made in different parts of North Germany have proved beyond denial that the assertion made by several eminent geologists, that a mighty deposit of salt stretches from the Lüneburger Heide to the coast of the Baltic, is perfectly correct. The deposit begins near Lüneburg, passes underneath the Elbe, and extends right across the Grand Duchy of Mecklenburg. Another branch goes in the direction of the Duchy of Holstein, *viâ* Legeberg to Elmshorn and Heide. Borings made at Lübtheen, near Hagenow, by order of the Mecklenburg government, have now reached a depth of 456 metres, and the thickness of the deposit of salt now reaches 130 metres; the basis, however, is not yet reached.

THE *Palæontologist* is the name of a new journal of small size published in Cincinnati, devoted to the subject indicated by its title. It will be published from time to time as matter accumulates.

AMONG the many rare shells lately belonging to Dr. Marie, of New Caledonia, is a new Murex, which will be described by Mr. Bryce Wright in the next number of the *Proceedings* of the Malacological Society of Belgium, under the name of *Murex hittonæ.*

STUDENTS of physics will be glad to learn that Gauthier-Villars has just issued a complete collection of the papers of the lamented Léon Foucault. They are preceded by a notice from the pen of M. Lissajous.

RECENT numbers of *Globus* contains an account, by Dr. Schröder, of his second visit to Cyprus in 1873.

HERR GERHARD ROHLFS will start for a new exploring tour to Africa in the first week of October. He will be absent some eighteen months, and he begins his journey *viâ* Tripolis and Wadai.

IN the Barmsee, a small lake situated in the Bavarian mountains, near the villages of Mittenwald and Krün, not far from the Austrian frontier, numerous piles, dating from pre-historic lake-dwellings, have just been discovered by Herr Zapf. The massive piles are standing upright in the lake; some of them still show incisions and spikes on their surface, indicating the spots where they were united, or where planks rested upon them. They stand in rows parallel to the southern shore of the lake. Other rows run in a northerly direction, but in the latter the piles are smaller and stand close side by side, forming a sort of palisade. None of the piles now reach the surface of the water. The total length of these pile-dwellings is about 200 metres.

THE *Precurseur d'Anvers* publishes a letter from Zanzibar stating that the Belgian expedition had reached a place situated some distance in the interior. Owing to a misunderstanding, they were compelled to engage in conflict with the natives, and eventually had to seek refuge in flight. It is not yet known whether they succeeded in escaping or were murdered.

AN American Microscopical Congress met at Indianapolis on August 14-17, under the presidency of Dr. R. H. Ward. Nineteen papers in various departments of microscopical research were read. The congress resolved itself into a permanent organisation under the name of the American Society of Microscopists.

THE Christchurch (N.Z.) *Press* contains a description of a very complete physical, chemical, and metallurgical laboratory which has been established in connection with Canterbury College. It is well provided with the best apparatus, and is well fitted both for original research and for student work.

WE have received a neat and attractive little "Guide to the Upper Engadine," by Dr. J. Pernesch, published by Orell Füssli and Co., of Zurich. It contains useful and well-arranged information, with a small map and twenty-one well-executed illustrations.

WE have received the July number of the *Anales* of the Argentine Scientific Society, which, besides an account of the proceedings of the society, contains a narrative of journeys in Patagonia, by Ramon Lista, papers on the composition of the water of the Uruguay, by Mr. J. J. Kyle, on the Hemiptera Argentina, by Carlos Bery, and on the flora of Paraguay, by Domingo Parodi.

WE are asked to publish the following statement:—During the recent opening of the Grosvenor Gallery on Sunday, nearly 6,000 persons availed themselves of the privilege of visiting the exhibition. This success has encouraged the committee of the Sunday Society to arrange for the exhibition of a series of water colour drawings of Swiss life and scenery, sketched in Switzerland by Mr. William L. Thomas. The exhibition will be opened on the first three Sundays in October, from 2 to 5 P.M., at 33, New Bridge Street, Blackfriars, E.C. (the late offices of the London School Board), and the public will have free access to it by means of tickets, which will only be issued to those applying by letter, and sending stamped and addressed envelope to the Honorary Secretary, 19, Charing Cross, S.W. The Committee of the Sunday Society intend to continue these Sunday Art Exhibitions from time to time, until the Society's object is accomplished, and the public Museums, Art Galleries, and Libraries, are all opened on the people's weekly leisure day. The Society will be glad to receive pecuniary and other assistance to enable the Committee effectively to carry on these exhibitions.

THE separation of the Central Bureau of Meteorology of the French Government is an accomplished fact, and the officers will be located in an hotel in the Rue de Grenelle, St. Germain, where no readings can be taken, the inspection of the sky being as difficult as from the British Office in Victoria Street. These peculiarities have raised much sharp criticism, and it is not certain that this solution will be accepted by the French Legislative Assembly. It has been suggested that the Bureau should be located at the Trocadéro, or on the top of the Arc de Triomphe, where there are magnificent rooms in which offices could be established.

THE additions to the Zoological Society's Gardens during the past week include a Bonnet Monkey (*Macacus radiatus*) from India, presented by Mr. Frederick Carter; two White-crested Touracous (*Corythaix albocristata*) from South Africa, presented by Mr. W. Wormald; a Green Turtle (*Chelone viridis*) from the Island of Ascension, presented by Capt. J. Smith; a Tabuan

Parrakeet (*Pyrrhulopsis tabuan*), a Masked Parrakeet (*Pyrrhulopsis personata*) from the Fiji Islands, purchased; a Chestnut-backed Weaver-bird (*Hyphantornis castaneo-fusca*), four Rufous-necked Weaver-birds (*Hyphantornis textor*), two Grenadier Weaver-birds (*Euplectes oryx*), a Barbary Turtledove (*Turtur risorius*), a Vinaceous Turtledove (*Turtur vinaceus*) from West Africa, a Turquosine Parrakeet (*Euphema pulchella*) from New South Wales, two Undulated Grass Parrakeets (*Melopsittacus undulata*), seven Crested Ground Parrakeets (*Calopsitta novæ-hollandiæ*) from Australia, deposited; eight Mocassin Snakes (*Tropidonotus fasciatus*), born in the Gardens.

THE FIGURE AND SIZE OF THE EARTH[1]

III.

DURING the years 1816-52 a Russo-Scandinavian degree-measurement was carried out by Struve and Gen. Tenner, of unusual length and wonderful accuracy. It extended from Hammerfest in the north (70° 40′) to Ismail in the south (45° 20′), a length of 25° 20′. From this it followed that for latitude 56° 3′ 56″, the degree length is 57,137 toises, and in this was included a Swedish degree-measurement which gave 57,209 toises as the length of a degree in lat. 66° 20′ 12″. At this time extensions of earlier operations were undertaken in other countries; as in England with the result of $\frac{1}{299}$ for the earth's oblateness. Everest extended Lambton's East Indian degree-measurement, which at present has a length of over twenty-one degrees. Also a longitude measurement begun at an earlier period in Central Europe was recommenced and reaches now from Brest, Paris, Strassburg, Munich, to Vienna. With the assistance of the new data the amount of the earth's oblateness was again investigated, and now that there was no doubt of the accuracy of the measurements, it was shown distinctly that the earth was not an entirely regular elliptical spheroid, that the flattening did not pass regularly over the earth's surface. The theory was next propounded that the earth was an ellipsoid of three axes, but the proposition was not fully supported by the measurements.[2] A newly elaborated mathematical method, by which from the existing measurements, the figure of the earth could be obtained, and by which the remaining errors could be reduced to a minimum, was now applied by the great Bessel to the data before him, and according to these principles and on the basis of the best measurements, he obtained dimensions of the earth which still form the ground of all astronomical and geodetical calculations, and which are as follows:—He found for the equatorial radius of the earth 327207714 toises = 6377400 metres; for the polar radius 326113933 toises = 6356080 metres; and for the length of the earth's quadrant 10000855765 metres; while he gave the earth's oblateness as $\frac{1}{298\cdot153}$. He also deduced formulæ giving the length of a degree or of a parallel of latitude for any part of the earth; these formulæ will be found in most geodetic handbooks. New values for the dimensions of the earth were, ten years ago, deduced by Leverrier with the assistance of other measurements, but they differ very little from those of Bessel, and in almost all scientific works Bessel's constants are adopted. Thus, about the middle of the present century the solution of the original problem has been attained. And yet since that time there has unmistakably been an altogether unusual progress in all departments concerned in the solution of the problem. First of all, mechanical precision has in the last decades attained such perfection, that now astronomical observations, and especially the geographical determination of places, can be made with considerably greater accuracy than was possible a few decades ago. Moreover, these improvements have been accompanied with extraordinarily suitable new methods. The telegraphic determination of longitude, a method for the determination of the lengths of parallels, has above all, especially in the last ten years, attained such perfection, theoretically and practically, that the measurements carried out on this method are most accurate, and we may justly expect in the future most brilliant results from it. Altogether the problem is near a more substantial solution now than it ever was before, as there are so many well-equipped observatories at work, bound together by a network of the most accurate determination of longitude and latitude, extended over the surface of the earth, and the completion of which is yet going on. Of the greatest importance also in this connection is the more recent theory of measurement, according to which the points to be connected need not lie in one and the same meridian or parallel, but, on the contrary, are connected by an arc of a great circle lying in any direction—the geodetic line.

Thus have we seen how from the remotest times, among all the nations of the earth not only has the wish to obtain a knowledge of the form and size of our dwelling-place prevailed, but also the most earnest activity in attaining this knowledge of nature; how this has in an increasing degree gone hand in hand with the progress of the mathematical and physical sciences, having at last reached a worthy solution in our time; and we have the best reasons for believing that, closely following the progress of the sciences, our knowledge in this connection will soon reach the highest degree of certainty.

Remarks on Karl Maria Friederici's Paper, by Col. Clarke, R.E.

One feature of modern geodesy that has been left unnoticed by the writer of the foregoing paper is the application of the theory of probabilities, under the form of the "method of least squares," to the reduction of the observations. In any network of triangulation if it were required to obtain the distance apart of two of the extreme points, we should obtain varying results according to the set of triangles used in the calculation, and the question arises, What is the degree of credibility to be given to each result, or what the "probable error" of each? This implies, of course, that there is a superfluity of observations, that is, more than are absolutely necessary to fix all the points. If there were no superfluous observations there could be but one result obtained—an advantage in one respect (in saving calculation)—but then we should be wholly at sea as to the degree of trust to be placed in this one result. The theory of probabilities teaches us how to treat superfluous observations, and practically it leads to the calculation of a system of corrections to all the observations in order to bring them into harmony. Now there could be found an infinite variety of systems of corrections that would harmonise the observations, but the particular system we are led to by the method of least squares has this feature, that the sum of the squares of the corrections is an absolute minimum. In plain words, the triangulation is harmonised with the least possible alteration of the original observations as a whole.

These calculations, however, involve an enormous amount of labour, and one is compelled sometimes to relax the rigour of the theory, and accept some slight modifications. For example, in the triangulation of Great Britain and Ireland this method required the solution of an equation of 920 unknown quantities; this hopeless task was evaded by breaking up the triangulation into some fifteen or more parts.

The principal triangulation of India—unlike that which uniformly covers the face of this country—consists of chains of triangles running in a meridian direction crossed by several other chains perpendicular to them; as the longitudinal series from Kurrachee to Calcutta, and that from Bombay to Vizagapatam, the north-east longitudinal series, and others. The reduction of these chains of triangles by the method of least squares is a vast labour not yet completed.

The enormous mass of the Himalayan Mountains causes, or rather might theoretically be supposed to cause, an immense disturbance of the direction of gravity at the stations of the Indian arc amounting at the northern stations to 30″, with smaller amounts as the distances of stations southwards increases. Now it is very singular that, except at the very foot of the mountains, these discrepancies do not actually appear (to anything like that amount) in the arc itself or when it is used in the problem of the figure of the earth. This very remarkable circumstance has led to the hypothesis that the attraction of the superincumbent visible mass must be compensated for by a diminution of density in the strata underlying the mountains. Pendulum observations made for the purpose of elucidating this point have shown conclusively that the density of these underlying strata *is* actually less there than elsewhere. A compensation therefore takes place—but in a general way only; it cannot be shown that it is a mathematically exact compensation, consequently there is some residual doubt as to what really are the deflections of the vertical at the astronomical stations of the Indian arc.

We may supplement Karl Maria Friederici's account of how to calculate a meridian arc by a description of the method fol-

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[1] Continued from p. 580.

[2] This is scarcely correct: the figure of three unequal axes agrees better with the observations than does the spheroid of revolution. But there is a necessity for this, and the ellipsoidal figure cannot be regarded as established.